# SHOCK ATTENUATION ACROSS THE CENTRAL PORTION OF A COMPLEX IMPACT STRUCTURE: SLATE ISLANDS, LAKE SUPERIOR, CANADA.

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The Slate Islands archipelago represents the central, uplifted portion of a ~30-32 km diameter, complex impact structure (1, 2). Target rocks consist of a variety of Archean and Proterozoic supracrustal and igneous rocks (3). Polymictic and monomictic, clastic matrix breccias and pseudotachylite in the target rocks, suevitic, allogenic breccias, shatter cones and shock metamorphic mineral deformation in target rocks and breccia components provide convincing evidence that the structure was formed as a result of asteroid or comet impact (1, 2, 4, 5).

**Method:** During our 1994 and 1995 field investigations, we have collected a large number of target rock samples to study rock brecciation (5) and shock metamorphic mineral deformation and to refine earlier shock attenuation studies (6, 7). Approximately 135 standard size thin sections were prepared and investigated in addition to about the same number of sections obtained from the Ontario Geological Survey (courtesy of R. Sage). Of these ~270 sections almost 100 were quartz bearing (and not from breccias) allowing a detailed study of the distribution of planar deformation features (PDFs) and planar fractures (PFs) in quartz across the archipelago. 54 of these quartz-bearing sections contained a sufficient number of quartz grains with planar microstructures for statistical analysis. This allowed us to estimate the shock pressure decay from a central area on Patterson Island (Fig. 1). In most thin sections investigated on the universal stage, we measured the orientation of planar microstructures in 20 quartz grains. We also determined the number (y) of quartz grains without planar microstructures per x (in most cases 20) grains that contain these features. This gave us, for each sample point, a frequency ratio $F=x/(x+y)$ (Fig. 1) of 0 to 1.

Most rocks underlying the Slate Islands archipelago are tectonically deformed and quartz is commonly strained. Therefore, we estimate that the accuracy of our measurements of the crystallographic orientation of the planar microstructures in quartz is only $\pm 5°$.

**Results and Interpretation:** In crystalline rocks, the formation of shatter cones require a minimum formational stress range of ~4$\pm$2 GPa (8). Shatter cones occur on all islands of the archipelago (4). This pressure is therefore the minimum shock pressure all Slate Islands target rocks were subjected to. Along the southwestern and western shore of Patterson Island, microstructures parallel to the (0001) crystallographic orientation in quartz prevail that are suggestive of shock pressures in the 5 to 10 GPa range (9; Fig. 1). Similar shock levels are recorded in the rocks of Mortimer Island and northeastern Patterson Island. A general increase to 10-15 GPa shock pressure (9) from 5-10 GPa eastward from the shore of western Patterson Island is indicated by the occurrence of microstructures parallel to the $\omega$ crystallographic orientation in addition to those parallel to (0001). Further to the east, samples with PDFs mainly parallel to $\omega$ (10-20 GPa) occur. From here, again further to the east, PDFs in quartz parallel to both $\omega$ and $\pi$ (20-25 GPa) were noted. On southeastern Patterson Island no planar microstructures were observed. However, shatter cones are common. The frequency ratio F is not a reliable factor to consider in shock pressure attenuation studies (Legend of Fig. 1). There is substantial overlap of these ratios for various pressure ranges.

The distribution of shock levels is not concentric around the area of highest (20-25 GPa) shock in central Patterson Island. The decrease in shock pressure from this 20-25 GPa area, ~ 2 km east of the eastern shore, to the 4$\pm$2 GPa range near this shore is abrupt (~20 GPa/km) compared to the distribution of shock levels to the west (~7 GPa/km). We tentatively interpret the higher gradient to the southeast as the result of a fault extending from the Sunday Harbour bay of southern Patterson Island to the east-central shore of this island (Fig. 1). We believe that along this fault a lower portion of the target was preferentially uplifted during the crater modification stage of the impact process, bringing weakly shocked rocks from deeper target rock levels in contact with more strongly shocked rocks. Occurrences of weakly shocked rocks close to relatively strongly shocked rocks of central Patterson Island and of rocks shocked to ~ 10-20 GPa at northern Mortimer Island may also be the result of differential movement during formation of the central uplift. Our results show that shock attenuation studies alone may not precisely define the center of impact structures.

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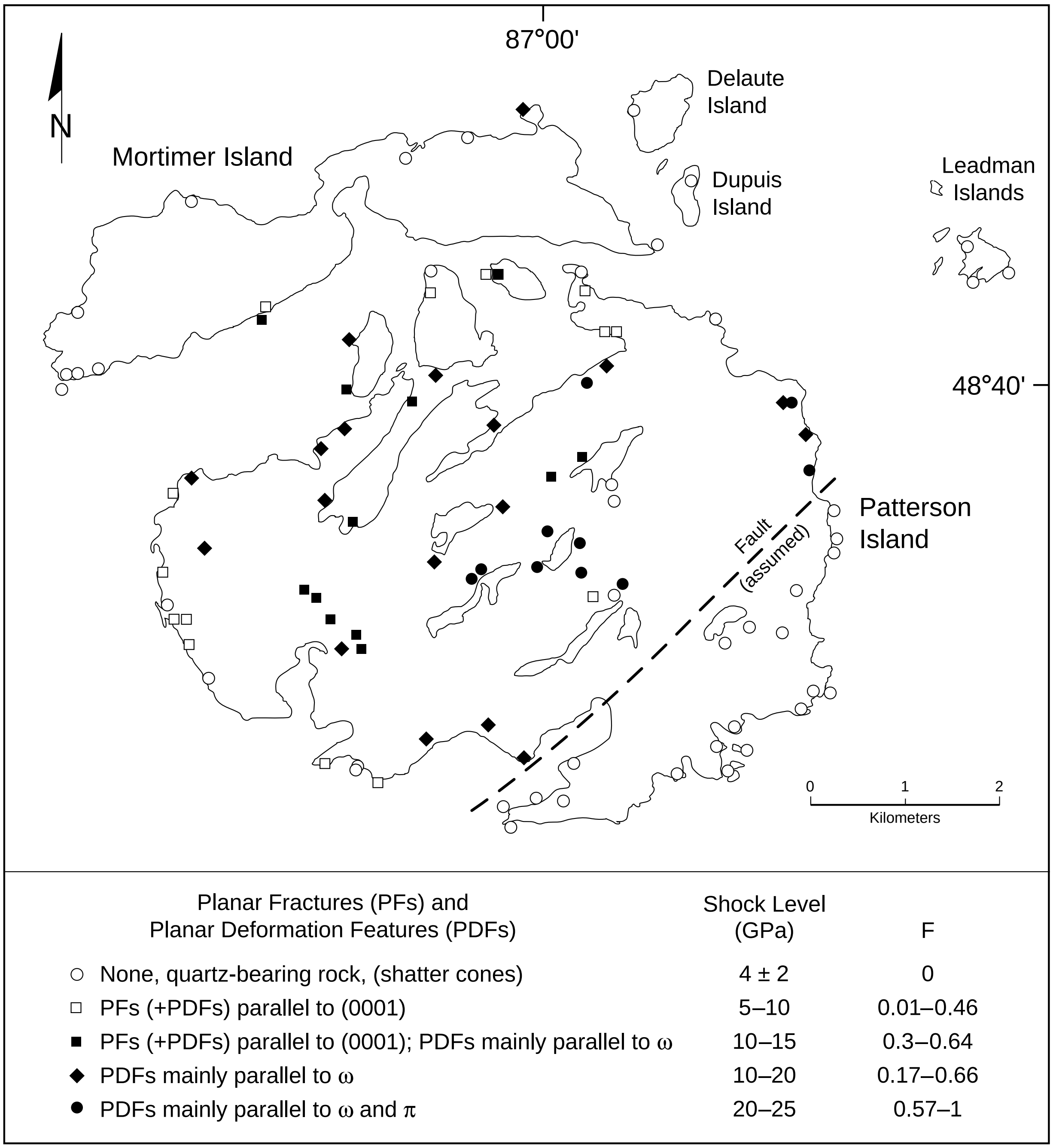


**Figure 1:** Shock levels across the Slate Islands archipelago